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NEW DESIGN FEATURES OF THE VENERA-9 AND -10 PROBES

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16. Abstract

The major design advance of the Venera-9 and -10 compared to previous Venera-7 probes is that part of it - the orbital module - is preserved and functions as a Venus staellite. Design engineer Ye. Ivanov describes design considerations, approaches, and alternatives on the way to this solution. The main objective was to retransmit telemetry and television signals from the descent module which can be transmitted to the orbital module (a few thousand km only) at a low power level, thus providing the opportunity for increased information volume transmitted during its short lifetime. Additional problems were associated with timing the direct visibility between the descent and orbital modules, which depended on the solution of entry and separation problems. The other innovation was the programmed variable velocity of the descent module for studying particular layers of the atmosphere.

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NEW DESIGN FEATURES OF THE VENERA-9 AND -10 PROBES

Ye. Ivanov, Design Engineer

And so, "Venera 9" has completed its flight along the /1
interplanetary path and begun to carry out scientific investigations in the regions of the "Morning Star", has begun to fulfill the function for which it was conceived, created and launched into orbit. And it was conceived several years ago. The designers were presented with the problem: create a space research apparatus for a much-planned expedition to Venus with the aim of obtaining extensive scientific material. It would seem to be the usual sort of assignment for those who contributed their toil and talent to the development of interplanetary stations of the type of "Venera" and, to a certain extent "Venera-4", the first descents into a planetary atmosphere on a parachute and investigations of the parameters of the atmosphere, "Venera-5" and "Venera-6", which accomplished investigations in deeper layers of the Venusian atmosphere and, finally, "Venera-7" and "Venera-8", which were lowered onto the planet surface...

But where all the preceding "Veneras" were in principle various modifications of a single design, the "ninth" was assigned a separate role.

In order to increase our scientific data, to organize more complex and standardized experiments, it was necessary to develop new patterns and designs of automatic interplanetary stations. Where the earlier orbital module with its sharply-directed parabolic antenna, which made possible communication with the remote space communications center, was lost almost

immediately after separation from the descent module, it was now necessary to preserve it and use it for further investigations.

How? "Clothe" it in a thermal protective covering? This was an acceptable method. In principle. But in the given case it appeared that the designers should follow a different course: "to avert the orbital module away from the planet", not to allow it to burn in the planet's aggressive atmosphere. This was the idea. The orbital module, located relatively close to the descent module (several thousand kilometers) is able to receive sufficiently clear signals issuing at high velocity (several thousand information units per second) and transmitted by a little-directed antenna of the descent module. In other words, in the course of a short time of launching into the atmosphere, the exploratory device of the descent module /3 can transmit to the orbital module a large volume of informations (much greater than possible in the case of direct transmission to the Earth). From the saved orbital module, this information can be transmitted to Earth using the already sharply-directed antenna.

In short, the idea of retransmission in classical form was decided upon not on Earth, but in space. Using all technological possibilities in the extremely complex climatic conditions of Venus, the designers first proposed transmitting for a distance of several thousand kilometers, and then for several hundred thousand kilometers...

Well then, how to save the orbital module? It is possible to proceed in two ways. First, to use the flight pattern of the "Mars" type station: to calculate the trajectory in such a way that the interplanetary space station would not fall

onto the planet but would pass close to it. Before the flight to Venus, at several hundred kilometers from its surface, separate the descent module from the station and, together with a special propelling device, "lead it away" from the trajectory of entry to the planet.

A second variation is also possible. The automatic interplanetary station is led out of the trajectory of entry to the planet, and after two to three days the descent module separates from it and flies toward the planet. In this case, the orbital module is led away in the direction of the so-called fly-over trajectory. If at the moment of closest approach to the planet a sufficient braking impulse is emitted, then the orbital module becomes an artificial satellite of Venus. From this satellite it is possible to carry out various investigations of the planet over a long period of time. Precisely this sort of variant was conceived in designing the "Venera-9" station.

The course from idea to embodiment was not easy. Drawings, calculations, test models, studies and, finally, the actual construction.

All this was done. However, the troubles are not over yet, even now that radio contact has been established between the two parts of the interplanetary station (orbital module and descent module). Automatic devices at an unimaginable distance from man have entered into a dialogue betwen themselves. The orbital module inquires, the descent module replies concerning the work they are doing in the planet's atmosphere. And this is not the subject of a science-fiction novel, but is an actual function proceeding in our time.

The function -- it's not that easy. To ensure successful radio communication (without it we would not receive the results

of the investigations), it is necessary to fulfill a series of conditions. The designers and calculators were faced with the problem of selecting from a variety of flights for the orbital module and descent module so that at the moment of radio communication they would not be shaded by the planet. The best variation was entry of the descent module into the atmosphere at a sharp angle, into the planet's region, in such a way that the orbital module would pass over it. The reason is this: a more sloping entry into the atmosphere causes less overload and, consequently, the descent module may be constructed in less stable and therefore lighter fashion. But... This "but" consists in the fact that in the given case the communication between the station modules will be short.

And more. The orbital module passes over close to the planet not in a straight line, but along a hyperbola. And it is all the steeper the closer the trajectory passes to the planet. Venus's gravitational field appears. For this reason, the orbital module passes beyond the planet's horizon very soon after the beginning of radiocommunication with the descent module, and the communication is cut off.

The optimal variant is divergence of the two parts of the station to opposite regions of the planet disk. While the descent module moves in the upper layers of the atmosphere and slows down, the orbital module, including the propelling device, passes into the orbit of a Venus satellite and, quickly circling the planet, appears in the range of direct visibility with the descent module. In order to achieve better extension of radio communication, the orbit of the artificial satellite may be made very elongated, highly elliptical.

This is only one of a series of problems that were solved in designing the automatic interplanetary station. The second consisted in ensuring exploration not only of the nebulous layer

of the planet, but also a maximal period of "work on the ground".

For an exploration of all sides of the nebulous layer of the planet, a special parachute system was created; this parachute system made it possible to change the descent velocity. It is constructed according to the principle, well-known among parachutists, of "sky acrobatics". Parachutists "jettison" one parachute, fall reducing the landing time, and again open up, this time a second parachute. So also the descent module: having completed its work in the upper layers of the atmosphere, it casts off the large parachute and with increasing speed rushes toward the surface, brakes and stabilizes with the help of a stiff canvas parachute of not very large size.

This, in brief, is what took place beyond the threshold of the bureau of design.